Palestine Technical University – Khadori
Faculty of applied science
Department of Molecular and Applied Biology
General biology lab I

| | |
|---|---|
| Experiment Name | Solutions, Acids, and Bases (The pH Scale) |
| Experiment Number | 5 |

| | |
|---|---|
| Student name | Hamza Sameh Othman |
| Student number | 201812127 |
| Teacher name | Dr. A. Saleh |
| Section number | 3 |
| Partners | Yaqeen, Tayseer, Eiad |

| | |
|---|---|
| Lab date | 22/10/2019 |

## INTRODUCTION

Chemicals in living systems are in solution. Biologists experiment with solutions because dissolved chemicals react more readily than solid, crystalline chemicals. These solutions must have a proper concentration of reactants for the reaction to happened. Those concentrations include the concentration of (H+) and (OH-) ions. The concentration of (H+) in any solution is measured by the concept pH.

In this experiment, we will learn how to use the pH meter, determine the pH value for different solutions, and indicate buffered solutions.

## THEORY

- Solutions consist of **solutes** (substance that is dissolved in a solution) and **solvents** (substance that becomes a solution by dissolving a solid, liquid, or gaseous solute).
  - **A mole** is a standard measure of the amount of a chemical (one mole of any substance has 6.02 × 1023 molecules)
  - **Molecular weight** is calculated from the atomic masses of each nuclide present in the molecule.
  - **Molarity (M)** is the concentration of a solution expressed as the number of moles of solute per liter of solution.
    - $\boldsymbol{No.moles = \frac{mass\ of\ substance}{molecular\ weight\ of\ the\ substance}}$
    - $\boldsymbol{Molarity = \frac{No.moles}{solution\ volume\ (L)}}$
  - **Dilutions:** is the process of decreasing the concentration of a solute in a solution, usually simply by mixing with more solvent like adding more water to a solution.
  - **Stock solutions**: is a concentrated solution that will be diluted to some lower concentration for actual use
    - $V_i M_i = V_f M_f$
  - **ACIDS AND BASES:**
    - **Acids:** are molecules that release hydrogen ions (H+) when dissolved in water. Acids increase the concentration of H+ in a solution.
    - **Bases:** are molecules that remove (H+) from solution.
    - **pH scale:** The pH is the negative logarithm of the concentration of H+;
    - $pH = -Log\ [H^+]$
  - **Measuring pH**
    - **pH paper:** is treated with a chemical indicator that changes colors depending on the concentration of H+ in the solution.

- **pH meter:** is a scientific instrument that measures the hydrogen-ion activity in water-based solutions, indicating its acidity or alkalinity expressed as pH.
  - **Buffers:** are mixtures of a weak acid and a weak base that can combine with a strong acid or base to limit changes in pH.

## OBJECTIVES

1. Apply the concepts of mole and molarity to prepare solutions.
2. Measure the pH of various liquids.
3. Demonstrate that buffers stabilize the pH of a liquid.
4. Measure the ability of commercial antacids to buffer the pH of a liquid.

## TOLLS AND MATERIALS

Test tubes, test tubes rack, pipits, Vinegar, Apple juice, Black coffee, Household bleach, 10 mM hydrochloric acid, 1.0 mM hydrochloric acid, 0.01 mM hydrochloric acid, Distilled water, Tap water, Soap solution, Shampoo, Deodorant, phosphate buffer, and NaCl.

## PROSESURE

- We used the pH meter to determine the pH values for different solutions.
- For understanding buffering concept, we prepared some buffered and nonbuffered solutions and determined its pH values before and after adding a strong acid.

## RESULTS

**TABLE 5.1**

**TESTING THE BUFFERING CAPACITY OF VARIOUS SOLUTIONS**

| PROCEDURE 5.2 SOLUTION | INITIAL PH | PH AFTER ADDING ACID |
|---|---|---|
| Water | 7.11 | 5.48 |
| 0.1 M NaCl | 6.56 | 3.32 |
| Tap water | 7.4 | 7.25 |
| 0.1 M phosphate buffer | 7.12 | 7.55 |

**Procedure 5.1** **Measure the pH of liquids**

Use pH papers to measure the pH of the following liquids. Be as accurate as possible and use a fresh piece of pH paper or pH dipstick for each test.

| | |
|---|---|
| Vinegar | 2.54 |
| Skim milk | |
| Guava juice | 3.3 |
| Orang juice | 3.74 |
| Buttermilk | |
| Black coffee | 6.13 |
| Sprite | 9.17 |
| Household bleach | |
| Mixture of Sprite and baking soda | |
| 10 mM hydrochloric acid | 2.17 |
| 1.0 mM hydrochloric acid | 4.27 |
| 0.01 mM hydrochloric acid | 6.5 |
| Distilled water | 6.75 |
| Tap water | 7.5 |
| Dissolved aspirin | 2.64 |
| Soap solution | 7.23 |
| Shampoo | 6.72 |
| Mouthwash | |
| Deodorant | 8.17 |

## QUESTIONS

**Question 1**

*a.* How many grams of sucrose would you dissolve in water for a total volume of 500 mL to make a 5% (weight/volume) solution?

$$5\% = \frac{50\ g\ \div 2}{1000\ mL \div 2}$$

$$= \frac{25g}{500mL}\ , we\ have\ to\ dissolve\ 25\ g\ of\ sucrose\ in\ 500mL\ of\ water$$

b. How many grams of calcium chloride would you add to water for a total volume of 500 mL to make a 5% (weight/volume) solution?

$\underline{we\ have\ to\ dissolve\ 25\ g\ of\ \text{calcium chloride}\ \ in\ 500mL\ of\ water.}$

c. How many grams of calcium chloride would you add to water for a total volume of 100 mL to make a 5% (weight/volume) solution?

$\underline{we\ have\ to\ dissolve\ 5\ g\ of\ \text{calcium chloride}\ \ in\ 100mL\ of\ water.}$

**Question 2**

***a.*** How many grams of NaCl (molecular weight = 58.5 g mole-1) would you dissolve in water to make a 0.5 M NaCl solution with 500 mL final volume?

$$\boldsymbol{Molarity = 0.5 = \frac{No.moles}{0.5\ L} \gg\ No.moles = 0.25\ mole}$$

$$\boldsymbol{No.moles = 0.25 = \frac{mass\ of\ substance}{58.5\ g} \gg\ mass\ of\ substance = 14.625\ g\ of\ NaCl}$$

***b.*** How many grams of NaCl (molecular weight = 58.5 g mole-1) would you dissolve in water to make a 50 mM NaCl solution with 500 mL final volume?

$$\boldsymbol{Molarity = 0.05 = \frac{No.moles}{0.5\ L} \gg\ No.moles = 0.025\ mole}$$

$$\boldsymbol{No.moles = 0.025 = \frac{mass\ of\ substance}{58.5\ g} \gg\ mass\ of\ substance = 1.4625\ g\ of\ NaCl}$$

***c.*** How many grams of sucrose (molecular weight = 342 g mole-1) would you dissolve in water to make a 0.22 M sucrose solution with 1 L final volume?

$$\boldsymbol{Molarity = 0.22 = \frac{No.moles}{1\ L} \gg\ No.moles = 0.22\ mole}$$

$$\boldsymbol{No.moles = 0.22 = \frac{mass\ of\ substance}{342\ g} \gg\ mass\ of\ substance = 75.24\ g\ of\ sucrose}$$

***d.*** How many grams of sucrose (molecular weight = 342 g mole-1) would you dissolve in water to make a 0.22 mM sucrose solution with 100 mL final volume?

$$\boldsymbol{Molarity = 0.00022 = \frac{No.moles}{0.1\ L} \gg\ No.moles = 0.000022\ mole}$$

$$\boldsymbol{No.moles = 0.000022 = \frac{mass\ of\ substance}{342\ g} \gg\ mass\ of\ substance = 0.0075\ g\ of\ sucrose}$$

***e.*** How many grams of calcium chloride (CaCl2; molecular weight = 111 g mole-1) would you dissolve in water to make a 0.111 M CaCl 2 solution with 1 L final volume?

$$\boldsymbol{Molarity = 0.111 = \frac{No.moles}{1\ L} \gg\ No.moles = 0.111\ mole}$$

$$\boldsymbol{No.moles = 0.111 = \frac{mass\ of\ substance}{111\ g} \gg\ mass\ of\ substance = 12.321\ g\ of\ CaCL2}$$

***f.*** How many grams of calcium chloride (CaCl2; molecular weight = 111 g mole-1) would you dissolve in water to make a 0.2 M CaCl 2 solution with 200 mL final volume?

$$\boldsymbol{Molarity = 0.2 = \frac{No.moles}{0.2\ L} \gg\ No.moles = 0.04\ mole}$$

$$\boldsymbol{No.moles = 0.04 = \frac{mass\ of\ substance}{111\ g} \gg\ mass\ of\ substance = 4.44\ g\ of\ CaCL2}$$

***g.*** If you were presented with 2 L of a 2 M sucrose stock solution, how many grams of sugar would be in a 100 mL aliquot?

$$\boldsymbol{Molarity = 2 = \frac{No.moles}{0.1\ L} \gg\ No.moles = 0.2\ mole}$$

$$\boldsymbol{No.moles = 0.2 = \frac{mass\ of\ substance}{342\ g} \gg\ mass\ of\ substance = 68.4\ g\ of\ sucrose\ are\ precent\ in\ 100\ mL\ of\ solution}$$

h. To prepare the 5% sucrose solution called for in Question 1a, how many moles of sugar did you add? What was the molarity of that solution?

$$\boldsymbol{No.moles = \frac{25\ g}{342\ g} = 0.073\ mole}$$

$$\boldsymbol{Molarity = \frac{0.073}{0.5\ L} = 0.146\ M}$$

i. To prepare the 5% calcium chloride solution called for in Question 1b, how many moles of calcium chloride did you add? What was the molarity of that solution?

$$\boldsymbol{No.moles = \frac{25\ g}{111\ g} = 0.225\ mole}$$

$$\boldsymbol{Molarity = \frac{0.225\ mole}{0.5\ L} = 0.45\ M}$$

j. How many milliliters of a 2 M sucrose solution would contain 1 mole of sucrose?

$$\boldsymbol{Molarity} = \mathbf{2} = \frac{\mathbf{1}}{\boldsymbol{volum\ \ L}} \gg volum = 0.5\ L = 500\ mL$$

**Question 3**

a. How many milliliters of concentrated (18 M) sulfuric acid (H2SO4) are required to prepare 750 mL of 3 M sulfuric acid?

- $(V_i M_i = V_f M_f) \gg \quad (18\,V_i = 750\ \times 3)\ \gg\ V_i = 125\,mL$

b. How would you prepare 100 mL of 0.4 M MgSO4 from a stock solution of 2 M MgSO4?

- $(V_i M_i = V_f M_f) \gg \quad (2\,V_i = 100\ \times 0.4)\ \gg\ V_i = 20\,mL$

$\underline{By\ taking\ 20\ mL\ of\ the\ stock\ sluotion, then\ adding\ 80\ mL\ of\ solvent.}$

c. How many milliliters of water would you add to 100 mL of 1.0 M HCl to prepare a final solution of 0.25 M HCl?

- $(V_i M_i = V_f M_f) \gg \quad \left(1 \times 100 = V_f\ \times 0.25\right)\ \gg\ V_f = 400\,mL$

**Question 4**

a. Vinegar has a pH of 3, and household ammonia has a pH of 11. Is the concentration of H+ greatest in the vinegar or ammonia? <u>In vinegar is greater.</u>

b. How many times different is the concentration?

$$\Delta pH = 11 - 3 = 8$$

- $pH = \ -Log\ [H^+] \gg 8 = -Log\ [H^+] \gg\ [H^+] = 10^8\ ions$

**Question 5**

Are your measured pH values similar to the calculated pH values? What are possible sources of error? <u>No, my measured pH values are not similar to the calculated pH values. Beyond the inherent problems caused by human error, it is very likely that the concentrations of reagents included in each method were not quite as measured (due to the limiting nature of significant figures). In addition to this, the limitation of exact measurements of included reagents makes it difficult to include the exact concentrations necessary.</u>

**Question 6**

a. Compare the initial pH and the pH after adding acid to each sample. Which is the most effective buffer? Which is least effective? the most effective buffer is **(Tap water)** and the least effective buffer was the NaCl solution.

b. What accounts for the different buffering capacities of these fluids?

The most effective buffer is the one in which the pH changes the least.

c. What is the biological importance of what you observed?

Blood in our bodies is buffered to maintain it at about 7.6 pH value.

## DISCUSSION AND CONCLUSION

The reactions in chemistry occur in aqueous media, which is necessary to contain certain concentrations of substances for different reactions, such as the concentration of hydrogen ions expressed in the concept of a pH, which can be calculated my pH paper or pH meter.

Buffered solutions (like blood) can minimize changes in pH and therefore maintain a proper concentration of H+ needed for different reactions.

Some pH values calculated practically can be different from the theoretical values that is mainly because of human errors like not preparing the precise molarity of some solution.

In the part of understanding buffers the best buffered solution was the tap water, that's indicates that tap water contain buffers initially or we have mistaken the value of pH after adding the strong acid, or have not added a sufficient amount of acid.

## INTERNET SOURCES AND REFERENCES

https://www.coursehero.com/file/p3pej27/11-10-pts-Discuss-reasons-why-your-measured-pH-values-would-be-different-from/

https://www.chegg.com/homework-help/compare-initial-ph-ph-adding-acid-sample-effective-buffer-l-chapter-5-problem-6q-solution-9780073532257-exc